

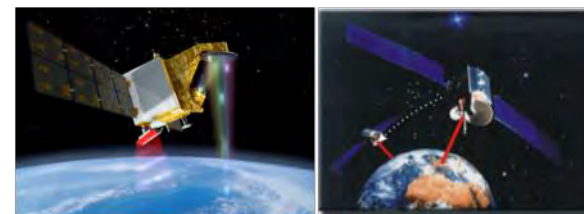
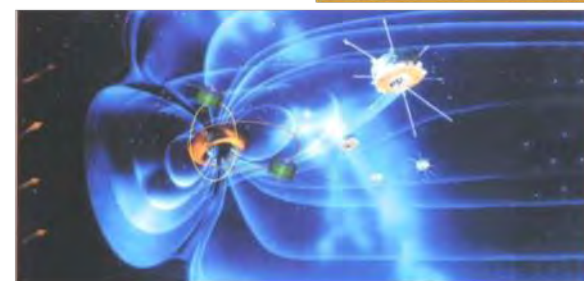
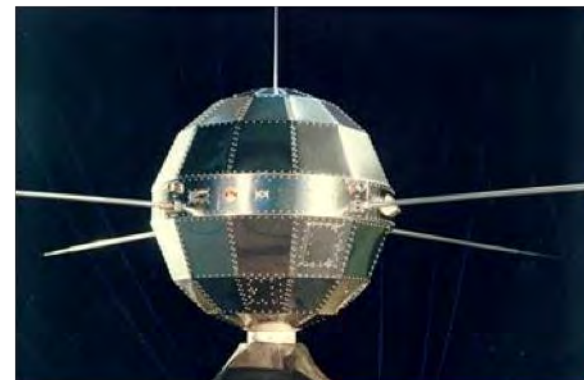
NSSC Update of EO Missions and CALVAL Projects

Xiaolong DONG, Heguang Liu

National Space Science Center
Chinese Academy of Sciences

(NSSC,CAS)

CEOS WGCV-40
Canberra, Australia
March 14-18, 2016



NSSC,CAS

National Space Science Center:

One of the Center/Institutes of Chinese Academy of Sciences
dedicated to space science and engineering

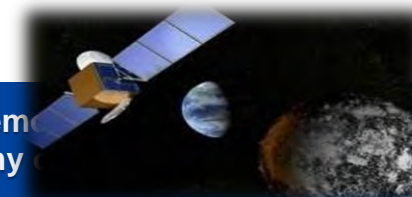
Planning, Development,
Management & Operation
of Space Science Missions
(2011~)

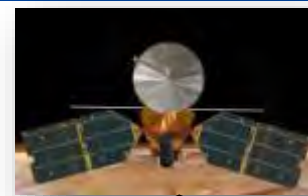
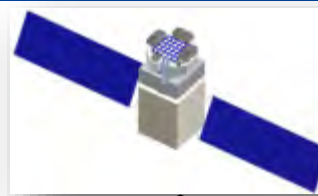
Research & Development of
Space Science and
Applications
(1958~)



NSSC: Snapshot of History

- 1958, established to start development of satellites in China
- 1960' s, leading player for Chinese space programs
- 1975-, started microwave remote sensing development in China
- 1980-90' s, pioneered the space environment exploration in China
- 1992-2003, science, applications and payloads for Chinese manned space flight program
- 2003-, development of payload for Chinese lunar missions
- 2011-, planning, selection, management, development, launching and operations of Chinese space science satellite missions





Space Science
Study Center

Mission
Management
Center

Mission
Operation
Center

Assurance
and Test
Center

Space Science Mission Planning, Management and Operations

Science and Technology Support for Space Science Missions

Dept of
Space Science

Dept of
Space Technology

Dept of
Space Environment

Dept of Microwave
Remote Sensing

SKL of
Space Weather

CSKL of
Complex Space
Systems

CSKL of Space
Environment

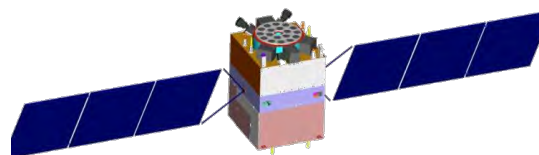
CSKL of
Microwave
Remote Sensing

Update of NSSC: Space Science Missions

Objective	Mission
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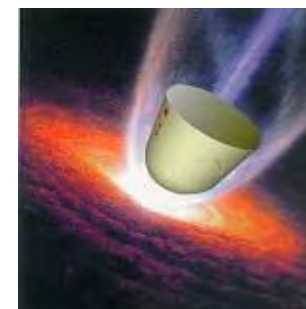
Black Hole

**HXMT
(2016)**



**Microgravity /
Life Science**

**SJ-10
(2016.4)**



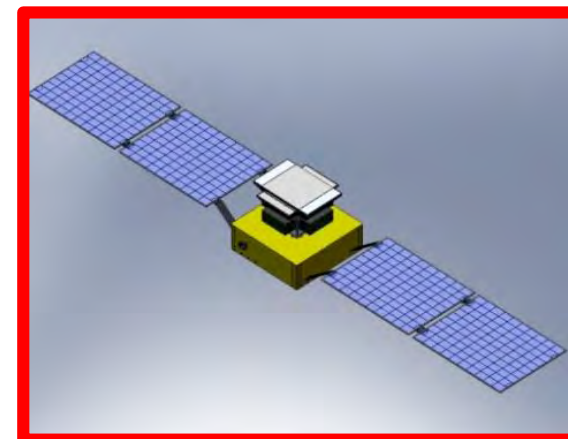
**Quantum
Theory**

**QUESS
(2016.7)**



Dark Matter

**DAMPE
(2015.12)**

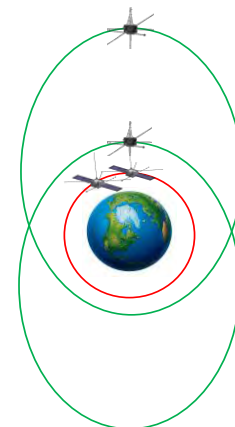


Update of NSSC:

Candidate Space Science Missions Under Intensive Study (planned for 2016~2020)

Link between Solar
wind, Magnetosphere,
and Ionosphere

**SMILE
(CAS-ESA)**

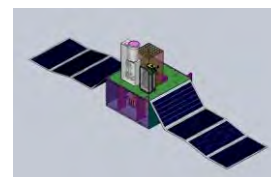


Magnetosphere,
Ionosphere and
Thermosphere Coupling

MIT

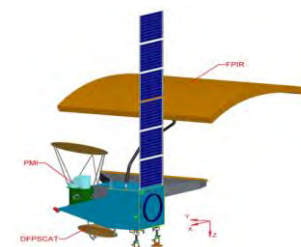
Exploring the dynamic
X-ray Universe

**EP
(Einstein Probe)**



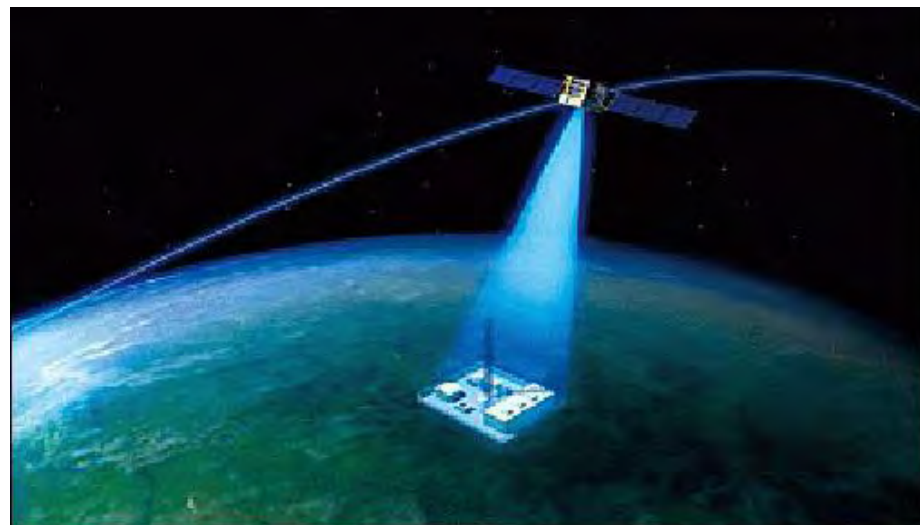
Synergetic Observations
of Global Water Cycle

WCOM



Update of NSSC: TanSAT

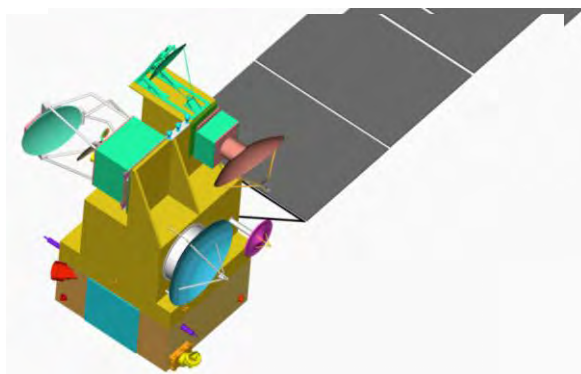
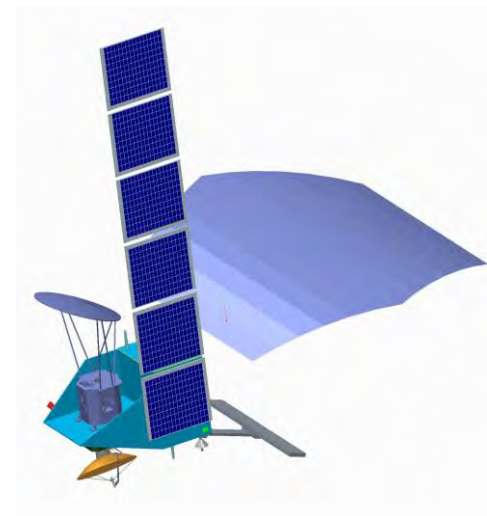
- MOST/NRSCC demonstration mission
- Role of NSSC
 - Management of mission system engineering
 - Mission operation
 - Ground segment
 - Data archiving and distribution



NSSC:

Payloads and Cal/Val for EO Satellites

- **CSIC-Civil Space Infrastructure of china**
 - HY-2 (A, B, C and Follow-on)
 - COSM
 - FY-3 and follow-on
 - CFOSAT
 - FY-4 (optical and microwave)
- **Strategic Priority Projects for Space Science**
 - WCOM



CSIC:

Civil Space Infrastructure of China (2016-2025)

- **3 series**
 - Land, ocean and atmosphere
- **7 constellations**
 - High resolution optical imaging constellation
 - mid-resolution optical constellation
 - SAR constellation
 - Water color constellation
 - Ocean dynamic constellation
 - Climate constellation (LEO)
 - Weather constellation (GEO)
- **3 specific satellite series**
 - Ocean environment surveillance satellite
 - Physical field satellite
 - Atmospheric composition satellite

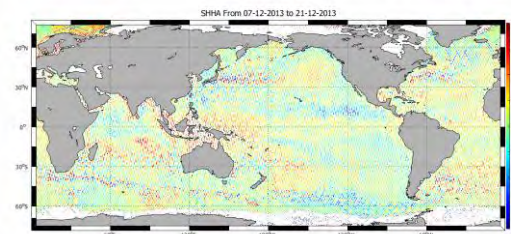
HY-2 update

■ HY-2A :

■ HY-2B/C :

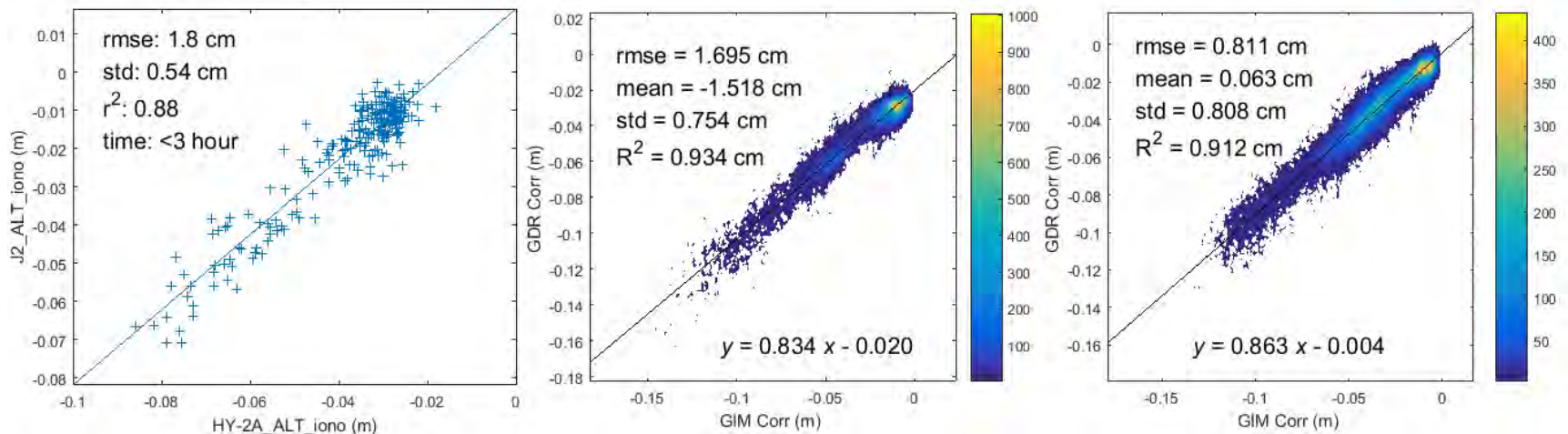
- DFRA: dual frequency radar altimeter :
Ku (13.58GHz) & C (5.25GHz)
- ACMR: atmospheric correction
microwave radiometer: 18.7 , 23.8 ,
37GHz
- SCAT: radar scatterometer: Ku-band
(RF switch network & receiver
- MWRA: microwave imager (6.6-37GHz)
L1 data production

■ HY-2 follow-on



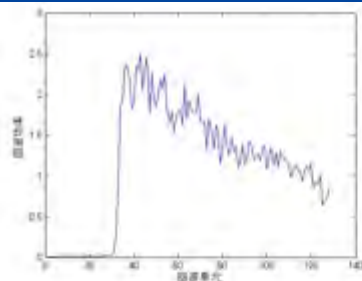
Improvement of HY-2A processing

- Ionospheric correction for NSOAS operational system
- Four-parameter re-tracking algorithm for NSOAS operational system
- Sea-level production refining: 6.2cm→5.8cm
- 3D non-parametric sea status bias correction

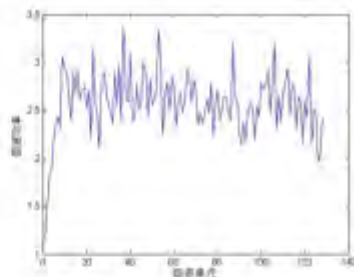


Crossover comparison of ionospheric corrections

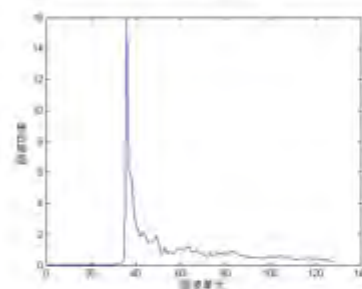
(left: HY-2A vs Jason-2; center: GIM vs HY-2A; right: GIM vs Jason-2)



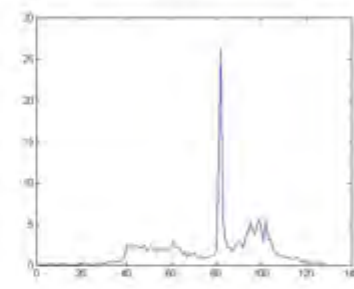
(a)



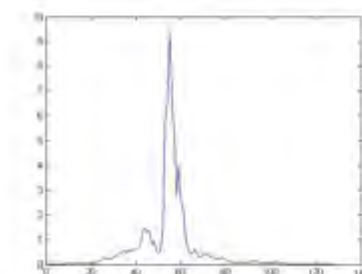
(b) ↙



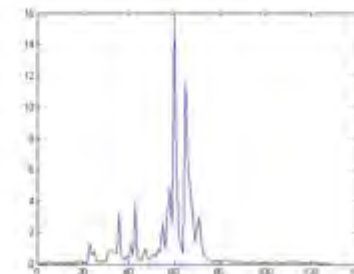
(c)



(d) ↙

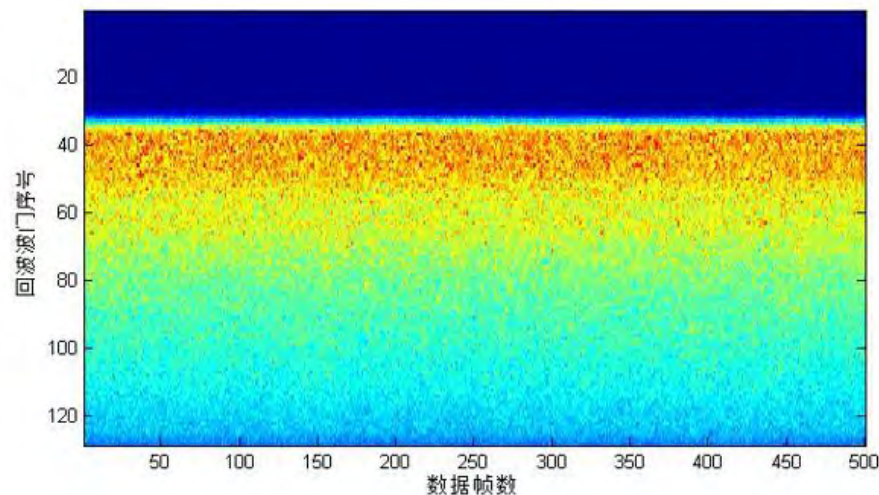


(e)

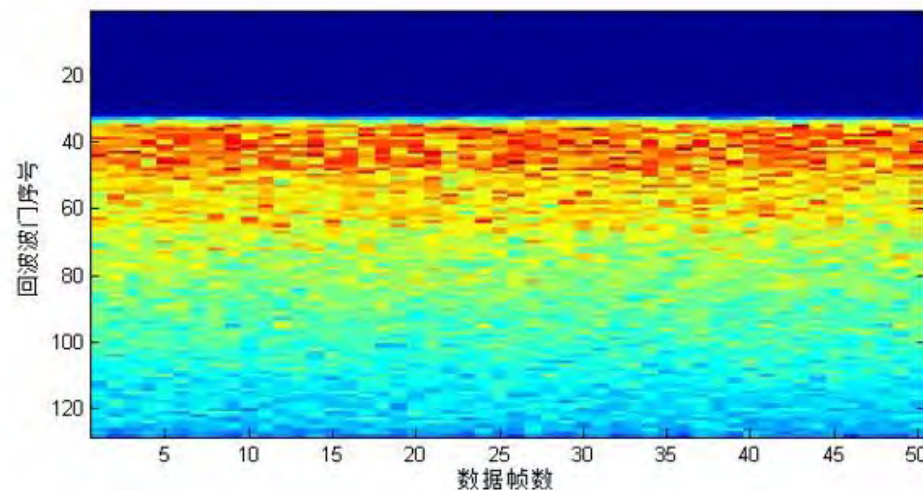


(f) ↙

HY-2A 高度计典型回波波形示意图↙



HY-2A 高度计阿拉斯加回波波形图↙



HY-2A 高度计苏门答腊岛回波波形图↙

Cross Comparison/calibration with Jason-2

STD bias < 5.8cm

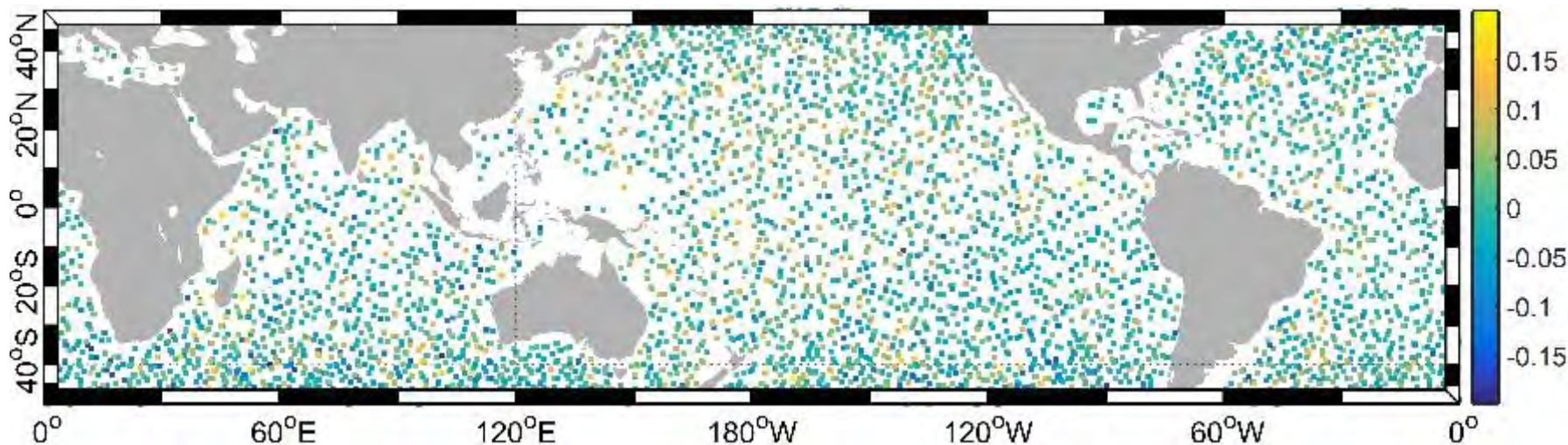
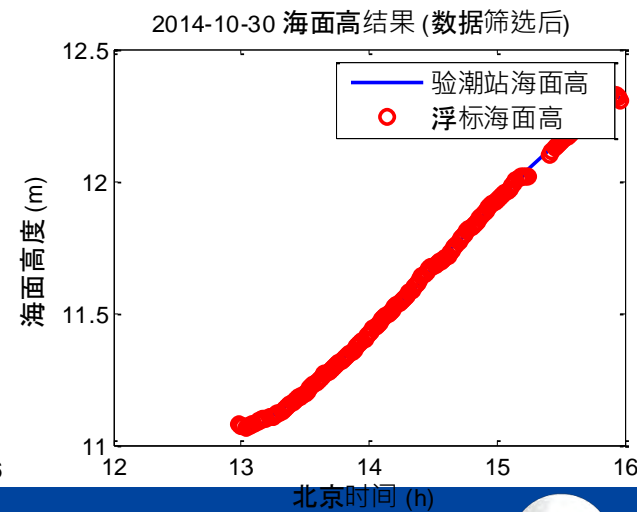
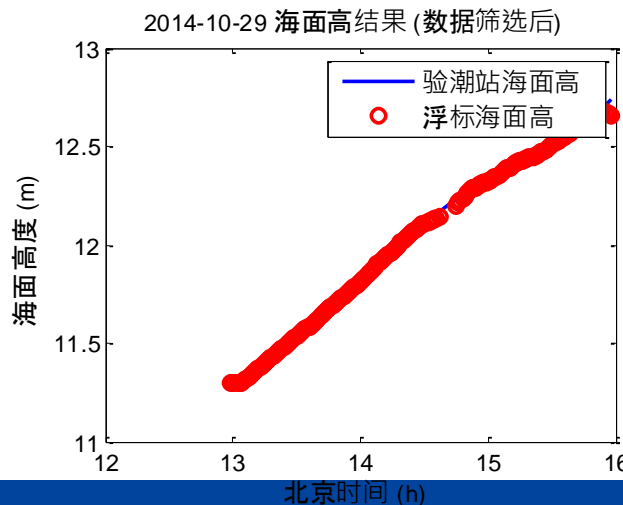
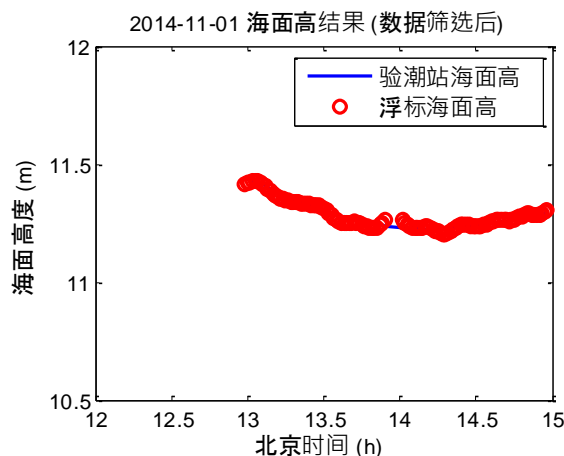
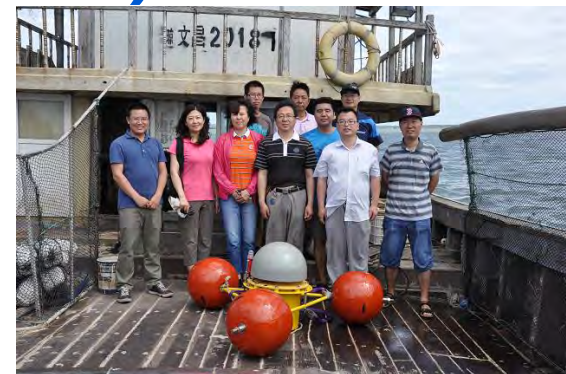
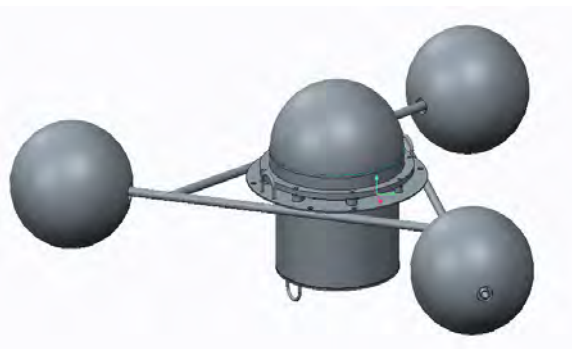
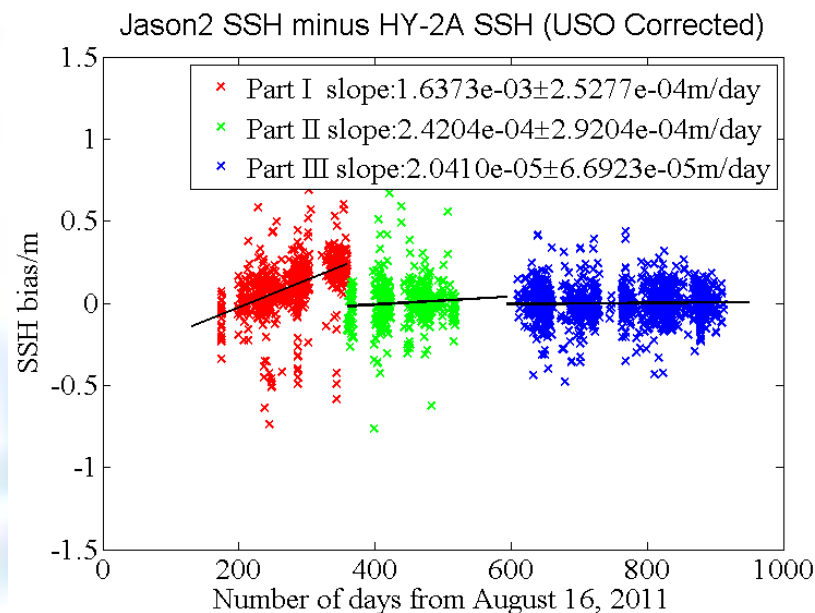
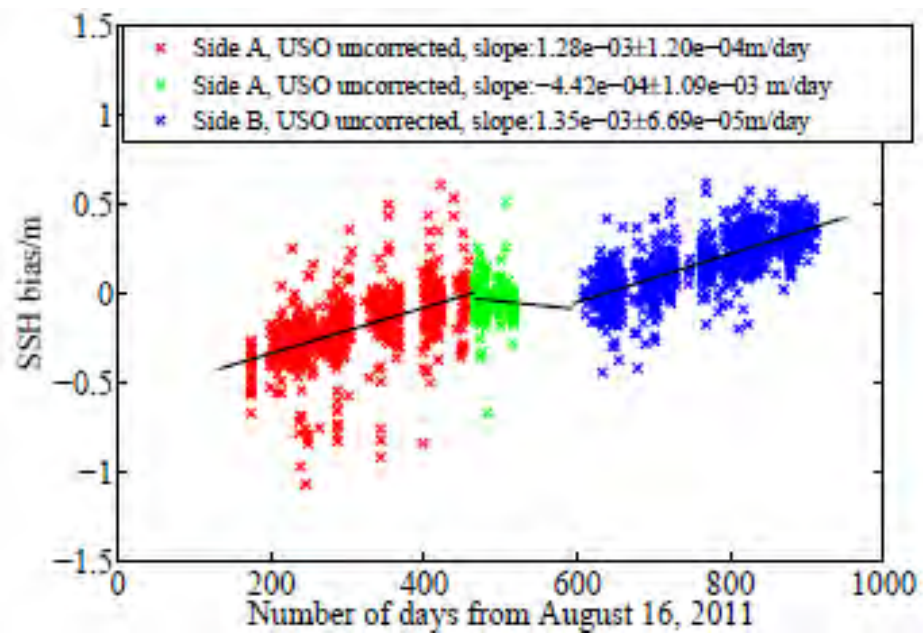


Figure. 2 Distribution of the differences of SSHs between HY-2A and Jason-2

Development and experiment of GNSS-buoy for RA calibration (0.7~0.87cm bias with tide stations)



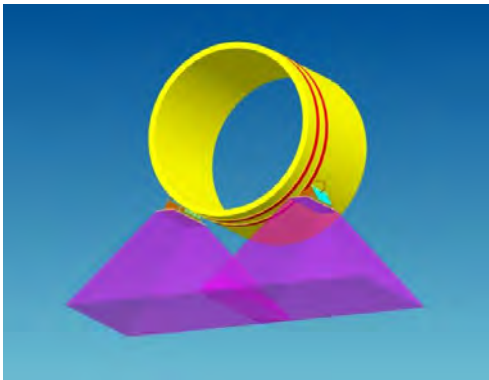
Calibration with ground-transponder (correction of frequency floating)



HY-2B/C and HY-2 follow on

✧ HY-2B/C

- Same payloads as HY-2A
- Improvement based on HY-2A
- Two satellite constellation (Polar SSO and inclined orbit)
- To be launch 2018/2019



✧ HY-2 follow on

WSRA: wide-swath radar altimeter

DFSC: C/Ku dual-frequency scatterometer

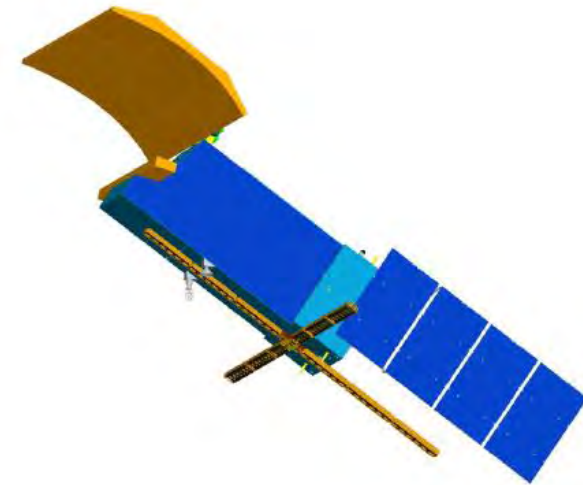
PRAD: Polarimetric microwave imager

- Intensive study started from 2016
- 1st satellite launch after 2020
- a pathfinder mission for WSRA will be launched in 2016

COSM update

Chinese Ocean Salinity Mission (HY-4)

- Mission requirements:
 - 0.1psu, 200km, monthly
 - With Simultaneous observation capability on ocean surface roughness and SST
- Schedule
 - 2011~2014: ground demonstration on different payload technology
 - 2015: mission definition, preliminary design, risk mitigation
 - Estimated launching: 2019



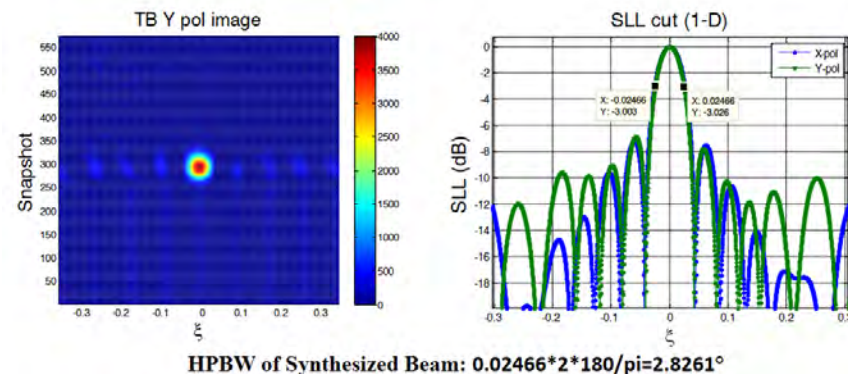
2 payloads:

- MICAP: microwave imager combined/Active Combined Imager (L, C, X, K band) (NSSC)
- M2DII: microwave 2-D interferometric imager (CAST-Xi'an)

MICAP Ground demonstrator development

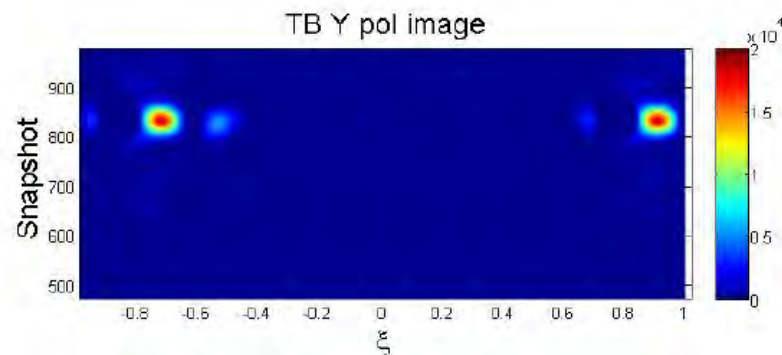
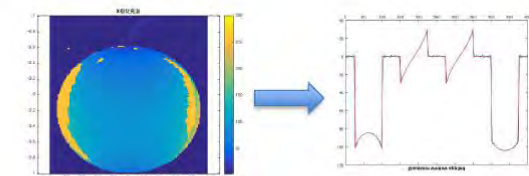
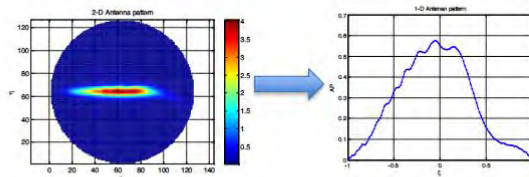


Integrated Feed Array

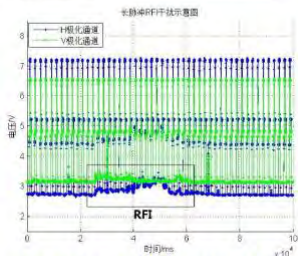


RFI detection & mitigation

High accuracy Brightness temperature reconstruction algorithm



$$\theta_{FOV} = \sin^{-1}(0.6353) \times 180 / \pi \times 2 = 78.8845$$



Ship-borne RFI investigation

Key Laboratory of Microwave Remote Sensing
Chinese Academy of Sciences



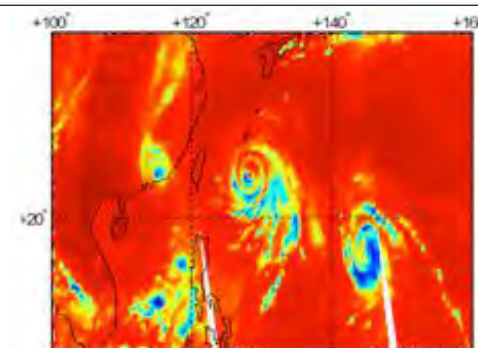
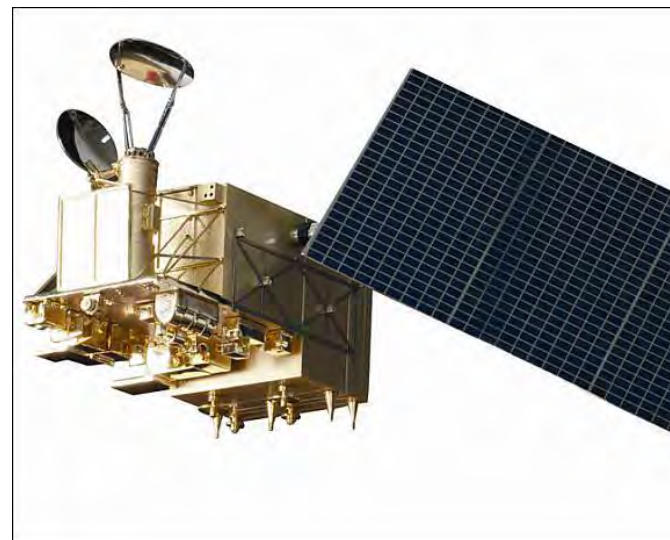
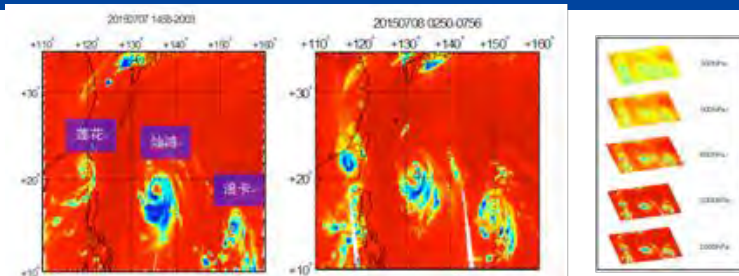
FY-3 update

■ FY-3A/B

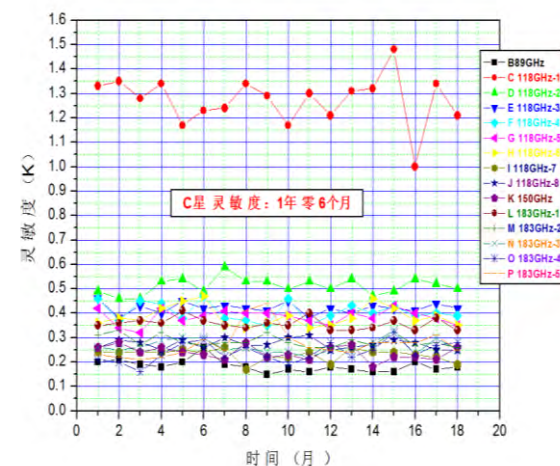
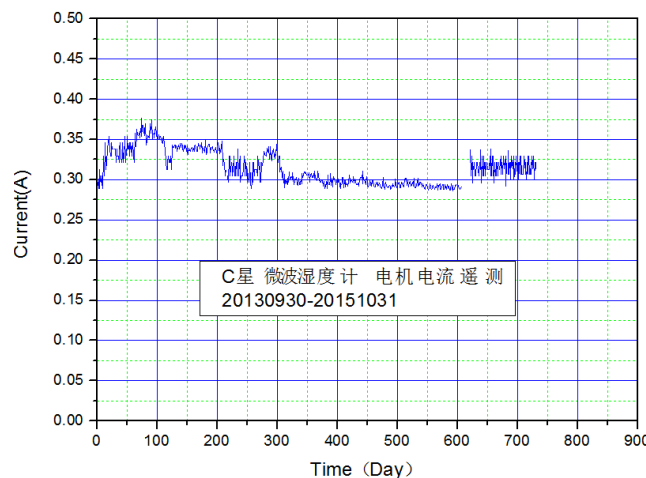
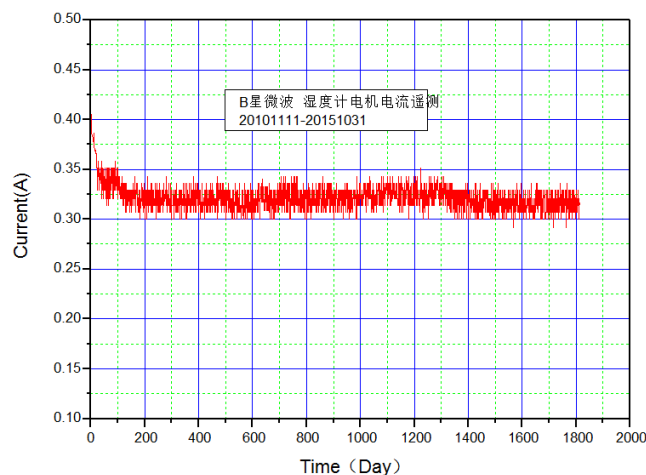
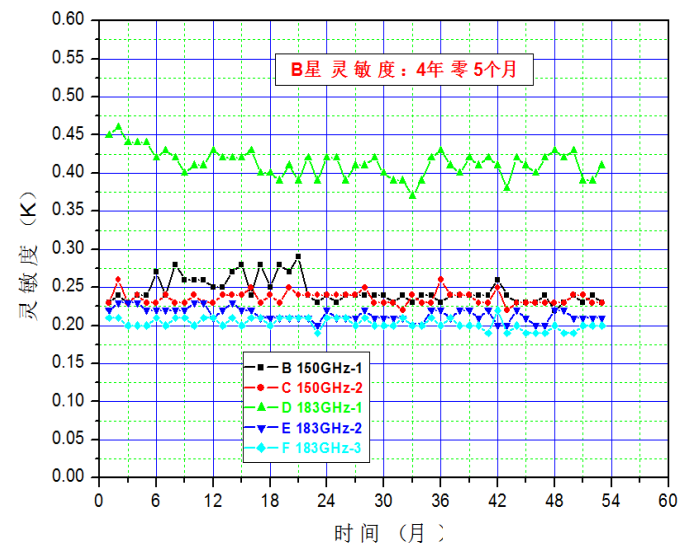
- MWHS: Microwave humidity Sounder
5 Channels: 150GHz: H, V-pol; 183GHz:
3channels for vapor
- FY-3A ended (launched 2008)
- FY-3B in good status (from 2010)

■ FY-3C/D

- MWHTS: Microwave Humidity and
Temperature Sounders
15Channels: 90GHz, 150GHz, 118GHz, 183GHz
- FY-3C: MWHTS in good status since 2013
- FY-3D: payload flight model ready in 2015, to
be launched in 2016

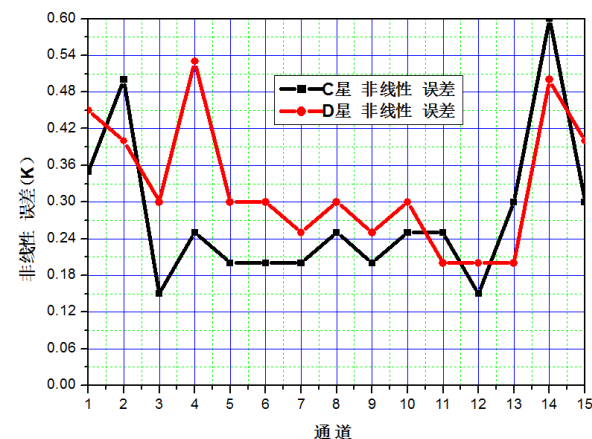
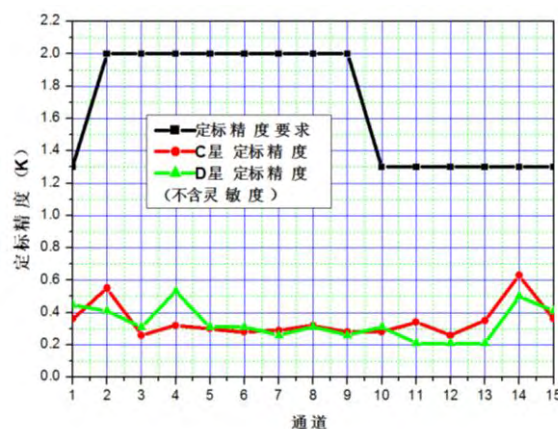
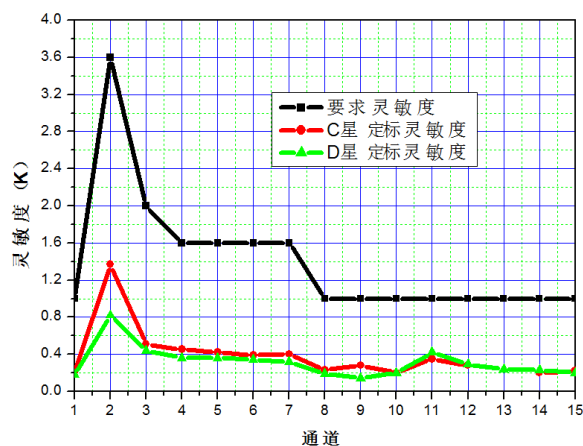
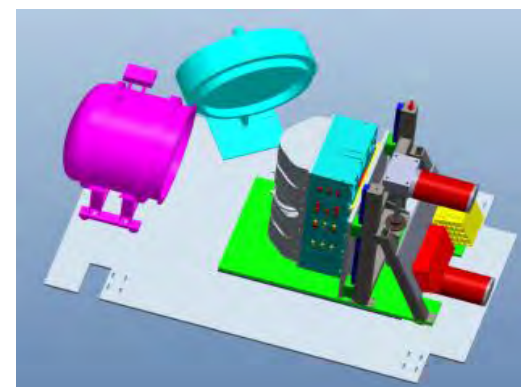
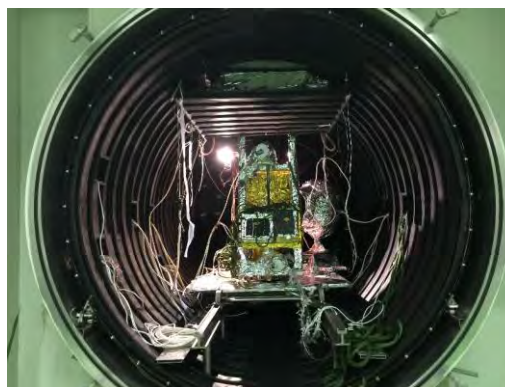


- ✧ FY-3B and FY-3C
- ✧ Performance well and stable
- ✧ Assessment and use in ECMWF
 - FY-3B from 2014
 - FY-3C from 2016



■ FY-3D

- Flight model test
- TV Test
- TV calibration



Comparison with HY-3C

Left: sensitivity; Middle: calibration bias; Right: nonlinearity error

CFOSAT update

■ Payloads:

- SCAT: rotating fan-beam scatterometer of ocean surface wind vector (ku band, by NSSC)
- SWIM: multiple beam radar for ocean surface wave spectrum (Ku band, by CNES)



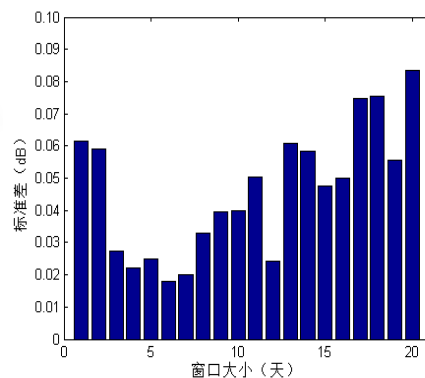
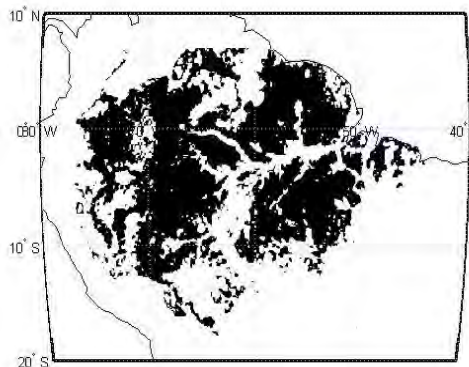
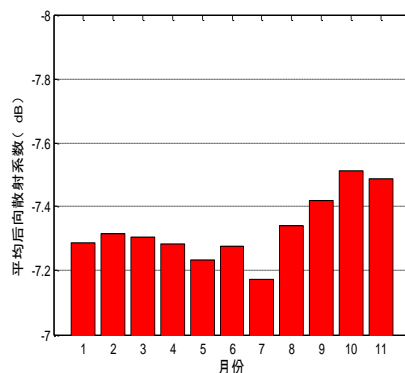
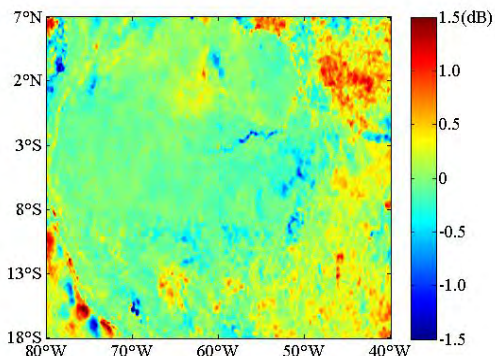
■ Schedule

- CDR: Nov 2015, after 2 year delay
- 2016: delivery of flight model
- 2017: satellite level test
- 2018: launch



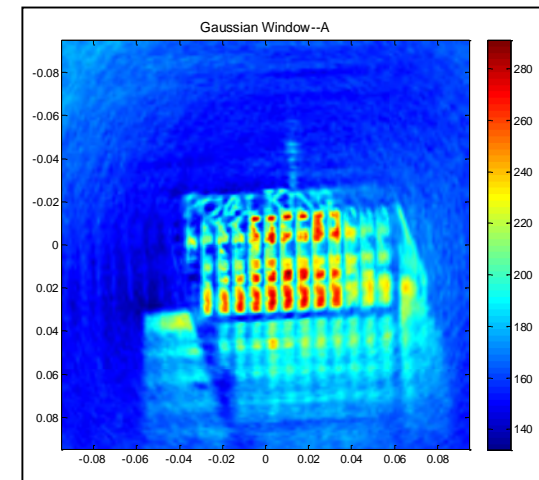
■ Preparation of postlaunch CAL/VAL of SCAT

- Antenna pattern confirmation with Amazon forest and GCS
- System calibration bias calibration by NOC
- Assessment of data available (QSCAT, HSCAT)
- Design of Cal/Val plan



FY-4 update

- Optical and microwave version
- FY-4A Optical:
 - to be launched in 2016
- FY-4 microwave
 - Satellite-level intensive study to be started 2016
- Payload development in NSSC
 - GIMS: geostationary Interferometric Microwave Sounder (NSSC+ESA)
 - 50-60GHz: Temperature channels: NSSC
 - 183GHz: vapor channels: ESA
 - DMGMS: dual-mode geostationary microwave sounder (NSSC+CAST-Xi'an)
 - 50-60GHz: interferometric imaging sounder
 - 90, 118, 167, 183GHz: real aperture reflector antenna
 - Schedule:
 - 2016-2018: intensive study
 - 2019-2021: qualification and flight model development
 - Estimated launch year ~2022



Preparation of CAL/VAL

■ Calibration

- Short-term period noise injection calibration
- Long-term period cold-sky calibration by satellite maneuver
- Cross-comparison/calibration with LEO microwave sounder/imagers)

■ Validation

- cross validation with GNOS (GNSS Occultation Sounder)
- Cross validation with LEO satellite
- Validation with ground reference site and ground based sounding

WCOM: water cycle observation mission

- SSO 6:00am 600km
- 3 payloads
 - IMI: L-S-C interferometric microwave imager
 - PMI: Polarimetric microwave imager (7.2-90GHz)
 - DPS: dual-frequency polarized scatterometer (X, Ku)
- Objective parameters
 - Soil moisture, ocean salinity, snow water equivalent, frozen-thaw, ocean surface evapotranspiration (wind and temperature)

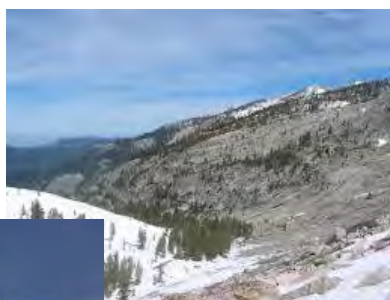


- Schedule
 - Intensive study: 2014-2015
 - Preparation of implementation: 2016
 - Qualification and flight model development: 2017-2019
 - Estimated launch: 2020

Preparation of CAL/VAL (WCOM Science team: Led by J-C Shi, RADI, CAS)

■ Algorithm development and validation for

- Soil moisture (RADI)
- Snow water equivalent (RADI)
- Frozen-thaw (RADI)
- Ocean salinity (NSSC)
- OSET (NSSC)



Development of microwave standard calibrator (polarimetric calibrator)

